Art. XVI.—*The Auriferous Sandstones of Chiltern.*

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In 1858 Conness and party discovered the goldfield that surrounds the present town of Chiltern. Their shaft was sunk near the N.W. corner of the block of land marked Bigbey (Allotment G, Sec. A, Parish of Chiltern), and the sample of gold obtained from the bottom was seen by the writer on its way to Beechworth, where the reward was claimed. Within a few weeks there were about 25,000 people at the Indigo Rush, and a township extended for four miles along the course of Indigo Lead.

Chiltern is 168½ miles from Melbourne, on the North-Eastern railway, and the position of the Caledonian Lead—a branch of the Indigo Lead, where auriferous sandstone occurs—is 3 miles N.W. in a straight line from Chiltern and about 2 miles due S. from Mount Pleasant.

Portion of the Caledonian Lead was worked by Mr. Barrass, Senr., and party, and more than twenty years ago Mr. Barrass discovered that some of the sandstone pebbles and boulders in the wash-dirt were auriferous. Forty or fifty loads were gathered up and crushed at an ordinary battery for a return of 15 to 20 dwt. of gold per load: this was only a fraction of the gold contained in the pebbles, as the gold is too fine for treatment in the ordinary stamp battery. Twelve loads more were obtained by this party on the surface at the Devonshire Lead, but whether they were obtained from that lead or had been carted over from the Caledonian Lead is uncertain. Altogether, probably, from 90 to 100 loads of these pebbles have been gathered up and treated for gold.

Auriferous pebbles were met with in the gravel of the lead from where the Caledonian Lead crossed the Devonshire Reef, and for about 400 feet down the course of the lead below the intersection. No auriferous sandstone pebbles were found in the

branch lead from the south, which joins the Caledonian Lead 2 chains above where the Devonshire Reef crosses it, nor were any found further up the lead, until within 100 feet of the Caledonian Reef. Where this reef crosses the Caledonian Lead and for 100 feet below the intersection, they were again met with.

These pebbles were so rich in gold that an effort was made to locate the beds of rock from which they had been derived. Messrs. Barrass and party expended much work in the search. They sank a shaft 135 feet through the alluvium on to a slate bar carrying gold, and then trenched the bed-rock below the lead for 300 to 400 feet below where the Devonshire Reef is crossed. The slate bar was 9 feet wide, and it carried by assay about 3 dwts. of gold per ton. This was sunk into for 20 feet, when the gold apparently ceased. This bar was not far from the reef. Westward the trenching did not disclose auriferous sandstone, but in a shaft sunk a little to the east of the other one, sandstone was found carrying gold. A few loads were crushed, and several loads dumped on the surface that yield a small prospect of microscopic crystalline gold.

More recent efforts to locate the source of the auriferous sandstone pebbles were made by Mr. J. Moore and others, where the Caledonian Lead crosses the Caledonian Reef. A shaft was sunk on the reef through 90 feet of alluvium, and near this nodular sandstone was cut carrying a little gold, and by trenching into the floor of the lead other bands of sandstones were cut carrying a little gold. A few loads yielded 14 dwts. per load, as I am informed by Messrs. H. Williams and Snow, who worked at this site, and who kindly supplied the information concerning it. In no case could the gold be traced more than 6 or 7 feet into the rock forming the floor of the lead. Another shaft was sunk 200 feet further east, but nothing obtained to encourage further outlay.

In 1887 Mr. Barrass, Senr., showed the auriferous sandstones to the writer, and from examples found by the latter, and assayed at the Mining Department, results up to and exceeding 20 oz. per ton were obtained. The boulders and pebbles are more or less rounded, and some show a nodular structure. They are generally white or grey on the outside, and yellowish-brown

from ferruginous stain inside. In size they range from a nutmeg to that of a man's head. Particles of gold are frequently visible on a fresh fracture to the naked eye, for the planes of these minute crystalline particles are highly polished, and reflect the light well. The pebbles are of varying degrees of coarseness; they are very porous, and are seen to consist of more or less rounded quartz grains with numerous small cavities between, and in these cavities is a ferruginous substance, and on this the particles of gold occur.

By crushing and panning-off these pebbles yield a "tail" of fine gold that is heavy and "hangs well" in the spoon or dish, but the particles are so microscopically fine that once they become dry they float away on the surface of the water. This gold is of good colour and high degree of fineness, and consists of small crystals that sparkle in the light. This distinctive character of the gold holds good both for the loose rounded pebbles of sandstone found in the gravel, and also for that found in the bed-rock below.

Last month the writer re-visited the locality with the object of arriving at some definite conclusion, and was fortunate enough to find a specimen which is the key to the whole matter. This is a pebble of slate $4\frac{1}{2}$ in. long, $1\frac{1}{2}$ in. wide, and $1\frac{1}{4}$ in. thick, and boat shaped. It was found about 400 feet lower down the lead than where the Devonshire Reef is crossed. It was split into two portions along a cleavage plane. One side is thickly spangled with crystalline dots of gold on the cleavage plane, and the cleavage plane of the other side has a few spangles of gold also. A margin around the edge of the plane with the most gold on it is bare of gold, showing that the pebble had the gold deposited upon it after it was formed into a pebble, and while it was in the gravel of the lead; and this shows that solutions containing gold must have traversed the lead, and where the conditions were suitable this gold was deposited in more or less crystalline form. Just as the gold was deposited in the slate pebble, so, no doubt, it was also deposited in the sandstone pebbles while they were in the gravel of the lead. By means of such a solution the slate rocks and sandstones forming the floor of the Caledonian Lead could also be impregnated with gold to a greater or lesser depth below the floor of the lead. To further check the matter the soil on

the ridges below both the Caledonian and Devonshire Reefs was carefully panned from a great many places, but not a particle of such crystalline gold as characterises both the pebbles and the bed-rock in the lead could be discovered.

It is necessary here to understand the physical conditions existing in the locality. The Caledonian Lead represents an old watercourse that flowed along the bottom of a valley, which has since become filled up with alluvial matter to a depth of 90 to 135 feet above the old water course, and this alluvial ground is, at the surface, from 10 to 30 chains across. North and south of the valley are spurs of Ordovician rock, and the floor of the valley is the same rock. Cutting through these rocks in a north-westerly direction and crossing through the valley from side to side are the Caledonian and Devonshire Reefs. On each side of the valley the spurs rise for from 100 to 200 feet above the present surface of the alluvial flat.

Rain falling on the spurs percolates through the sandstones and slates, dissolving alkalies and other matters, and finds its freest channel along the course of quartz-lodes, such as the Caledonian and Devonshire, and this water, after traversing such auriferous lodes through a depth of 200 or 300 feet, is discharged into the lead drainage where the reefs are crossed. During its passage through the gold-bearing quartz and accompanying sulphides it dissolved some of the gold, and where it flows into the lead re-deposited the gold in the porous sandstone pebbles and in the rocks forming the floor of the lead, where the conditions were favourable.

The Caledonian Lead is practically dry in the summer season, as the Indigo Lead drains the water away from it ; but in the winter the rains percolate through the rocks and through the alluvium, and then water flows down its course, percolating through the pebbles, etc., and in this manner depositing gold. Doubtless the water contained but a very small amount of gold, and the process of deposition in the pebbles and bed-rock was a very slow one. Very probably it was also a process continued to the time the lead was worked, and even may now be active.

Auriferous pebbles also occur in other localities on this field. The writer obtained examples on the Indigo Lead, above its junction with Wallace's Gully Lead, and also in the last but one north branch on the west side of Wallace's Gully Lead.

As these sandstone pebbles carrying gold are not derived from beds of auriferous sandstone, the quest for the latter can be dropped: but the facts disclosed bear very distinctly on the problems of the enrichment and impoverishment of auriferous lodes above water level, also on the presence of gold in solution in the waters of alluvial leads.

In the early days of quartz mining in this State it was a common circumstance to find at and near the surface that the joints and faces of the quartz were coated with extremely thin films of gold. Such films were no doubt formed from solutions that had previously dissolved some of the gold out of the adjacent stone. The term "New Chum Gold" was applied to such occurrences, because inexperienced miners were apt to over-estimate the value of such finds. Paint-gold was another name applied to such occurrences.

In most auriferous quartz lodes the ore above permanent water level differs entirely in nature from that below water level. Below water level the ore is as originally formed, and consists of quartz and other gangue and metallic minerals in the form of sulphides, except the gold, which is in metallic form, the so called refractory ores. Such ores are due to deposition from the lower circulating waters, which have brought them up from deeper levels.

Above the permanent water lines the ores met with have resulted from the de-sulphurising and oxidising of these sulphide ores, through the agency of rain and air, which obtain access to the lode-material.

To the upper zone of auriferous lodes the term "zone of enrichment" has been applied in many cases. This is an apt definition, for enrichment of the surface and to shallow depths of such lodes has frequently taken place, and in one of the following ways:—

First.—Mechanically, where the crumbling away of the gold matrix has set the metal free and allowed it to drop near the outcrop of the lode. Innumerable examples of such enrichments near the cap of the lode were met with in Victoria, in all the Australian States, and in South Africa.

Phenomenal yields were common in Victoria at and near the outcrop, and for a short distance down, or as far as the quartz

was "rubbly." When solid ground was reached there was often a sudden and serious dwindling of the yields. In such cases the gold about the out-crop might represent the contents of many feet of the lode above the present surface of the ground.

Secondly.—Chemically, by the action of rain-water percolating through the strata and draining into the lodes and along them, as the easiest course, to lower levels. Such waters and the air acted on the sulphides, decomposing them, and in turn charged with the products of decomposition dissolved some of the gold, and bore it away to some other portion of the lode where the conditions were favourable, and there the gold was re-deposited. In this way some lodes have become enriched in their lower levels by gold brought in solution from the higher levels.

Rich ore has often been found in quartz reefs just above water level. From the appearance of the gold in the quartz in many cases enrichment might be inferred, for the gold appears to have pushed the quartz apart as it increased in bulk in the cracks and fissures until the stone has a crushed appearance. Cases of this have been observed at Maldon, Sitlington's Mystery Reef, near Elaine, at Tangil and elsewhere. That gold was deposited subsequent to the deposition of the quartz in some cases is fully proved by instances that the writer met with in West Australia. A nugget weighing over 90 ozs. was seen that had evidently been formed in a cavity lined with quartz crystals, for it retained sharp hollow casts in its substance of quartz crystal pyramids.

For the self-same reason that portions of auriferous quartz-lodes above the water level may become enriched by gold removed from some other portion of the same lode, the portion of the lode above water level may, and does, often represent a zone of impoverishment. This must be the case at the Caledonian Lead, where gold dissolved from the Caledonian and Devonshire Reefs finds its way into the channel of the Devonian Lead.

Cases are common in Victoria where highly auriferous lodes are cut across by a fault, and beyond the fault the lode is barren, or nearly so. In such cases one explanation may be that the fracture has opened a means of surface drainage by which the gold has been leached out of the barren sections of the lode.

On the lateral secretion theory of lodes the Caledonian Lead occurrence has also a bearing, for where the walls of lodes or the

country rock containing the lodes are found to carry some proportion of the same minerals as abound in the lode itself, may these not have been derived from the lode, instead of the other way about? In very many cases it has been noticed that country rock close to unusually rich portions of a reef is also auriferous. At the Mystery Reef, Elaine, this was the case; the soft, yellow, decomposed slate carrying several dwts. of gold to the ton.

Where gold occurs in sandstone and in slate in these States it may generally be considered as of secondary origin; it is usually not constant for any great distance.

The crystallized gold, often found where indicators of slate are crossed by quartz veins and generally at the site of some displacement of the strata, is certainly of secondary character, and has accreted at these particular sites from solutions that have leached the gold out at some higher level. To such origin, also, must be attributed the rich leaders at Elaine and elsewhere.

It is evident that the percolation of surface waters through auriferous lodes that dissolve gold, and carry it away in solution through other parts of these lodes, and that also drain into the channels of alluvial leads and flow down them, is still in action, and has to be considered as an agency at work both in the lodes and in alluvial leads.

If such waters could deposit gold in the planes of a slate pebble, and in the small cavities of sandstone pebbles, there seems no valid reason why some should not be deposited on the particles of gold in the leads also. Examples showing such to be the case have not been met with by the writer, though the possibility was demonstrated long ago by the late Mr. C. S. Wilkinson. For the data concerning work done, etc., my acknowledgments are due to Mr. Barrass, Senr., one of our veteran miners, and also to Messrs. Snow and H. Williams, of Mount Pleasant.